Primary Visual Cortex Inspired Feature Extraction Hardware Model and Applications

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Abstract (should be within 1st page) :

This dissertation proposes a primary visual cortex inspired feature extraction hardware model that demonstrates brain functions. The model incorporates five special functions: edge detection, SLIT detection, parallax detection, motion detection, and approach detection. Firstly, we suggested combining the edge and SLIT functions into deep neural networks to reduce the training time, pruning weight, and operation. As a result, training time is diminished by 40%, 40%, and 32%, respectively, with MNIST, CIFAR, and SVHN databases on Lenet-5 and CNN models. They also decrease by approximately 10% on larger paradigms such as VGG-16 and VGG-19 with the CIFAR database. Notably, the SLIT architecture merges with most popular CNNs at a slightly sacrificing accuracy of a factor of 0.27% on MNIST, ranging from 0.5% to 1.5% on CIFAR, approximately 2.2% on ImageNet, and remaining the same on SVHN databases. The parameter and operation can omit about 80% in the first and second layers compared with other researches. Secondly, an optimization hardware model for the inference phase is showed remarkably efficiently on latency, power, and hardware resources. With the Lenet-5 architecture, the results are reduced by 39% of latency and 70% of hardware resources with a 0.456 W power consumption compared to previous works. It is also decreased approximately 10% on hardware resources and latency with the VGG models. An advance in latency is also proved in this research. An enhancement has gained from 2.6% to 16%, equaled with the traditional approach. In the third proposal, an effective success in adversarial attack applications when applying the SLIT function on spiking neural networks. In against adversarial attack for deep spiking neural networks through white-box settings with different noise budgets and variable spiking parameters, the proposal has improved the accuracy of the results when increasing noise budget. With white-box adversarial attack applications on SNNs, the accuracy of the proposal is approximately 70% higher robustness than the previous works.